

Children's dental health in Europe

Caries treatment need in 5- and 12-year-old children from eight EU countries

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The purpose of this study was to develop methods to evaluate treatment needs (TNEED) and previous treatment (TDONE) in different populations. In the collaborative study, 'Children's Dental Health in Europe', the methods were used in connection with a clinical examination to document and compare treatment needs in 200 5-year-olds and 200 12-year-olds from each of the 8 participating countries. The study comprised a total of 3200 children from Belgium, Germany, Greece, Ireland, Italy, Scotland, Spain, and Sweden. The method for calculating TNEED was validated by estimation of required time to meet the treatment needs (TNTIME). The calculated TNEED shows a clear relationship with the evaluated TNTIME, and the method is applicable to different population subgroups. The results revealed large differences in both TNEED and TDONE among the different countries and between the two age groups.

□ *Dental caries; epidemiology; international collaboration*

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As part of the study 'Children's Dental Health in Europe' both the calibration procedures used (1) and the dental health of 5- and 12-year-old children living in eight EU countries were presented (2). Great differences were found in the caries experience, the level of restorative treatment provided, and the preventive measures—for example, the use of fissure sealants (2).

The caries indices, DMFT/DMFS, are conventionally used to express the level of dental health, but registration of DMFT/DMFS does not adequately reveal the true treatment need. For a reliable estimate

of the actual dental health, with regard to dental care required, it is necessary to evaluate the treatment needed. This is also important as a basis for planning delivery of dental care, in terms of personnel and financial resources (3). Knowledge of the actual treatment need in groups of children can also help assess priorities for different measures to be undertaken in subgroups within the population. To date there are few studies on estimates of treatment need. It is therefore of importance to develop methods to estimate the actual treatment need in different age groups or different parts of the population.

The aims of the present paper are to develop methods to estimate treatment need due to caries and, further, to compare the treatment need and previous treatment of carious lesions, treatment done, in the samples of 5- and 12-year-old children from the eight participating EU countries.

Materials and methods

The material comprised 200 5-year-olds and 200 12-year-olds from each of 8 EU countries, altogether 3200 individuals. The children lived in the following urban areas: Gent, Belgium; Berlin, Germany; Dundee, Scotland; Athens, Greece; Cork, Ireland; Sassari, Italy; Valencia, Spain; and Stockholm, Sweden, and were randomly selected from primary and secondary schools in their respective area. Material selection, examination procedures, and criteria for caries are described in a previous paper (2). It is essential to emphasize that,

This is part of a collaborative study on Children's Dental Health in Europe comprising the following countries, centres, and persons: Belgium: Dept. of Paediatric Dentistry, University of Gent, Professor Luc Martens and Dr. Luc Marks; Germany: Bezirksamt Neukölln von Berlin, Abt. Gesundheit Zahnärztlicher Dienst, Dr. Sylvia Dohnke-Hohrmann; Greece: Greek Society of Dentistry for Children, Athens, Professor Constantine Oulis, Dr. Kiriaki Tsinidou and Dr. George Vadiakas; Ireland: WHO Collaborating Centre for Oral Health Services Research, Cork, Dr. Helen Whelton; Italy: Istituto di Clinica Odontostomatologica, University of Sassari, Professor Giuliano Falcolini, Dr. Guglielmo Campus and Dr. Aurea Lumbau; Scotland: Dental Health Services Research Unit, University of Dundee, Dr. Cynthia Pine; Spain: Clinica Dental Infantil, Valencia, Dr. Luz Aguiló and Dr. Filo Estrela; Sweden: Department of Medicine Karolinska Institutet, Stockholm, and Public Dental Health Stockholm County Council, Dr. Ann-Kristin Bolin; The Institute for Postgraduate Dental Education, Jönköping, Professor Göran Koch; and Department of Oral Radiology, Karolinska Institutet, Stockholm, Dr. Anders Bolin.

Table 1. Mean and standard deviations (*s*) for different treatment needs in the 5-year-old children at the individual level. The following codes are used for the respective samples: I = Belgian, II = German, III = Greek, IV = Irish, V = Italian, VI = Scottish, VII = Spanish, and VIII = Swedish

Sample	Treatment need, 1 surface filling, mean $\pm$ <i>s</i>	Treatment need, 2 surface filling, mean $\pm$ <i>s</i>	Treatment need, multi-surface filling, mean $\pm$ <i>s</i>	Treatment need, pulpal involvement, mean $\pm$ <i>s</i>	Treatment need, extraction, mean $\pm$ <i>s</i>
I	0.44 $\pm$ 0.91	0.34 $\pm$ 1.02	0.11 $\pm$ 0.43	0.01 $\pm$ 0.10	0.09 $\pm$ 0.35
II	0.51 $\pm$ 1.00	0.69 $\pm$ 1.19	0.19 $\pm$ 0.56	0.13 $\pm$ 0.51	0.15 $\pm$ 0.73
III	0.47 $\pm$ 0.90	0.45 $\pm$ 1.00	0.26 $\pm$ 0.77	0.14 $\pm$ 0.58	0.04 $\pm$ 0.21
IV	0.63 $\pm$ 1.10	0.45 $\pm$ 0.90	0.13 $\pm$ 0.51	0.12 $\pm$ 0.41	0.07 $\pm$ 0.31
V	0.58 $\pm$ 1.12	0.61 $\pm$ 1.18	0.45 $\pm$ 0.92	0.48 $\pm$ 1.27	0.46 $\pm$ 1.88
VI	0.52 $\pm$ 0.84	0.52 $\pm$ 1.05	0.01 $\pm$ 0.14	0.18 $\pm$ 0.53	0.10 $\pm$ 0.40
VII	0.22 $\pm$ 0.57	0.24 $\pm$ 0.78	0.10 $\pm$ 0.48	0.07 $\pm$ 0.33	0.01 $\pm$ 0.40
VIII	0.17 $\pm$ 1.00	0.09 $\pm$ 0.39	0.01 $\pm$ 0.07	0.00 $\pm$ 0.00	0.01 $\pm$ 0.10

although the study comprises children from eight different countries, there is no claim that the children are representative for the whole country, but only for that region. Therefore the codes used in the tables and figures aim at the Belgian sample, the German sample, and so forth.

The treatment need was registered for the children when examined during the calibration procedures, and good inter- and intra-examiner reliability was achieved both for this variable and for the other clinical variables (1). Thereafter, treatment need was registered at the tooth level at the clinical examination of the total material in the respective country.

For each tooth the treatment need was registered by one of the following scores: TN1 = one surface filling indicated; TN2 = two surface filling indicated; TN3 = multi-surface filling indicated; TN4 = endodontic treatment (pulpal involvement) indicated; and TN5 = extraction indicated. The scores together represent the Treatment Need scale (TN scale).

The treatment need is a means of estimating the clinical work necessary to restore a tooth affected by dental disease, as there might be a discrepancy between dental status and treatment need. By assessing the actual treatment need for each tooth, a clearer view of the real treatment need was achieved than was possible by counting only carious surfaces, which would not disclose zero treatment need in cases of arrested caries or the need for endodontic treatment or extraction in cases of deep cavities. To evaluate treatment need in each subject, the Treatment Need (TNEED) was calculated as follows:

$$\text{TNEED} = \sum_i \text{TN1}_i + 2x \sum_i \text{TN2}_i + 3x \sum_i \text{TN3}_i + 4x \sum_i \text{TN4}_i + 5x \sum_i \text{TN5}_i$$

where *i* represents the *i*'th tooth.

The different treatment needs have thereby been quantified by the weights 1, 2, 3, 4, and 5, respectively.

Another aspect of treatment need is the estimated time required to treat lesions caused by caries, here named Treatment Need Time (TNTIME). To examine the validity in the applied TN scale, the calculated TNEED was reflected in TNTIME, based on the current itemized schedule of fees for the Swedish Dental Insurance Scheme, which in turn is based on studies of the time required to perform different items of treatment. For each of the different levels of treatment need, TN1–TN5, the time required for the treatment has been estimated. According to this scheme, a one-surface filling takes 11.1 min to perform, a two-surface filling 18.3 min, a multi-surface filling 25.2 min, and an extraction 16.5 min. For the 5-year-olds TN4 was considered to indicate an extraction—that is, requiring the same treatment time as TN5. For the 12-year-olds TN4 has been calculated as the cost of endodontic treatment of a tooth with two root canals.

The calculations for TNTIME will then be as follows: For the 5-year-olds:

$$\begin{aligned} \text{TNTIME} = & 11.1x \sum_i \text{TN1}_i + 18.3x \sum_i \text{TN2}_i \\ & + 25.2x \sum_i \text{TN3}_i + 16.5x \sum_i \text{TN4}_i \\ & + 16.5x \sum_i \text{TN5}_i \end{aligned}$$

where *i* represents the *i*'th tooth.

For the 12-year-olds:

$$\begin{aligned} \text{TNTIME} = & 11.1x \sum_i \text{TN1}_i + 18.3x \sum_i \text{TN2}_i \\ & + 25.2x \sum_i \text{TN3}_i + 77.0x \sum_i \text{TN4}_i \\ & + 16.5x \sum_i \text{TN5}_i \end{aligned}$$

In addition to calculation of actual TNEED in the different country samples, the dental decay due to caries

Table 2. Mean and standard deviations (*s*) for different treatment needs in the 12-year-old children at the individual level. The following codes are used for the respective samples: I = Belgian, II = German, III = Greek, IV = Irish, V = Italian, VI = Scottish, VII = Spanish, and VIII = Swedish

Sample	Treatment need, 1 surface filling, mean $\pm$ <i>s</i>	Treatment need, 2 surface filling, mean $\pm$ <i>s</i>	Treatment need, multi-surface filling, mean $\pm$ <i>s</i>	Treatment need, pulpal involvement, mean $\pm$ <i>s</i>	Treatment need, extraction, mean $\pm$ <i>s</i>
I	0.39 $\pm$ 0.83	0.08 $\pm$ 0.39	0.10 $\pm$ 0.35	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00
II	0.24 $\pm$ 0.61	0.14 $\pm$ 0.50	0.05 $\pm$ 0.23	0.00 $\pm$ 0.00	0.01 $\pm$ 0.14
III	0.49 $\pm$ 0.90	0.38 $\pm$ 0.91	0.21 $\pm$ 0.57	0.05 $\pm$ 0.31	0.10 $\pm$ 0.38
IV	0.60 $\pm$ 1.06	0.17 $\pm$ 0.48	0.04 $\pm$ 0.20	0.02 $\pm$ 0.17	0.03 $\pm$ 0.17
V	0.86 $\pm$ 1.33	0.38 $\pm$ 0.78	0.13 $\pm$ 0.51	0.11 $\pm$ 0.36	0.04 $\pm$ 0.21
VI	0.62 $\pm$ 1.06	0.11 $\pm$ 0.37	0.01 $\pm$ 0.07	0.00 $\pm$ 0.00	0.05 $\pm$ 0.36
VII	0.54 $\pm$ 1.04	0.31 $\pm$ 0.73	0.06 $\pm$ 0.36	0.05 $\pm$ 0.24	0.02 $\pm$ 0.12
VIII	0.29 $\pm$ 0.65	0.11 $\pm$ 0.46	0.02 $\pm$ 0.17	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00

with regard to previous treatment, here named Treatment Done (TDONE), was calculated as follows:

TDONE = 5 $\times$ number of missing teeth due to caries + number of filled surfaces.

An estimate of the total treatment situation due to caries—that is, both performed and unperformed treatment—in each age group in the respective countries is shown by TNEED plus TDONE.

Statistics

To compare the mean values for TNEED, TNTIME, and TDONE in the different countries and

age groups, Fischer's least significant difference procedure, the LSD test (4), was used.

Results

Mean and standard deviations for treatment need in the different treatment need classes are shown for the 5-year-olds in Table 1 and for the 12-year-olds in Table 2. The need for extractions in the 5-year-olds is most obvious in the Italian sample and that in the 12-year-olds in the Greek sample.

The treatment need due to caries, TNEED, is presented for both age groups in Fig. 1. In all the

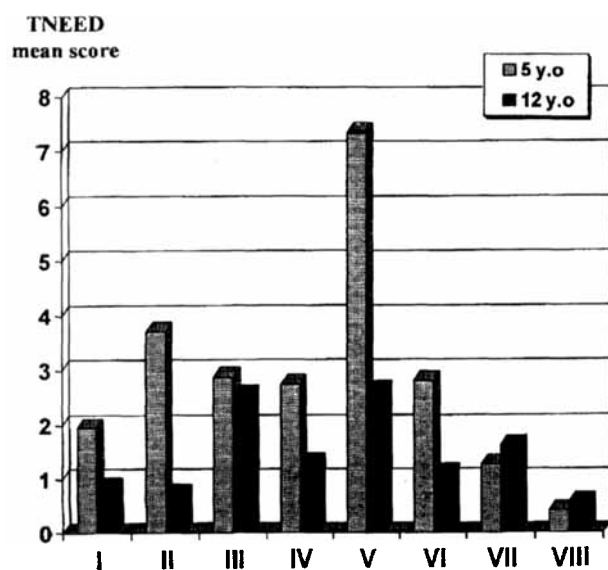


Fig. 1. Treatment Need (TNEED) presented as mean score for each age group in the eight samples. The following codes are used for the samples: I = Belgian, II = German, III = Greek, IV = Irish, V = Italian, VI = Scottish, VII = Spanish, and VIII = Swedish.

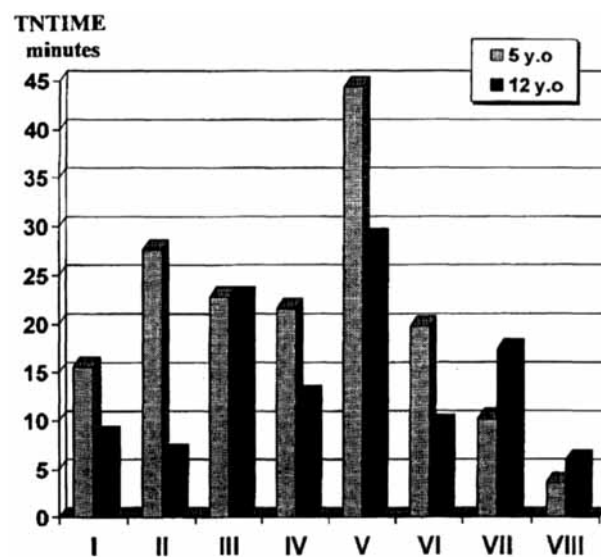


Fig. 2. Treatment Need Time (TNTIME) presented as mean values for each age group in the eight samples. The following codes are used for the samples: I = Belgian, II = German, III = Greek, IV = Irish, V = Italian, VI = Scottish, VII = Spanish, and VIII = Swedish.

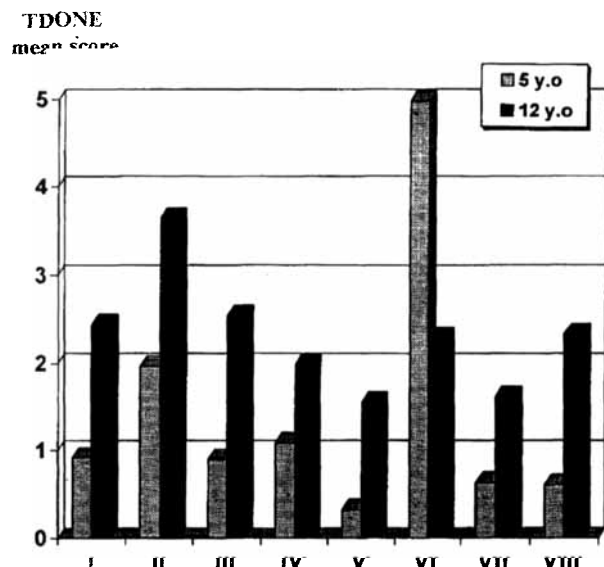


Fig. 3. Treatment Done (TDONE) presented as mean score for each age group in the eight samples. The following codes are used for the samples: I = Belgian, II = German, III = Greek, IV = Irish, V = Italian, VI = Scottish, VII = Spanish, and VIII = Swedish.

country samples except the Greek, Spanish, and Swedish ones, there is a marked difference in treatment needs between the two age groups.

All samples except the Spanish and Swedish ones have figures showing a higher total treatment need for the 5-year-olds than for the 12-year-olds. The most pronounced treatment need in the 5-year-olds is seen in the Italian sample, followed by the German, Greek, Scottish, and Irish samples. The treatment need for the 12-year-olds is most pronounced in the Italian and Greek samples, followed by the Spanish and thereafter the Irish and Scottish samples.

The total treatment need due to caries, expressed in hours, TNTIME, for the 5- and 12-year-olds is presented in Fig. 2. The difference in TNEED between

the two age groups is less pronounced when expressed as TNTIME than as TNEED, except for the Spanish and the Swedish samples.

Previous treatment, TDONE, measured as a mean score for the two respective age groups in the samples from the eight countries, is shown in Fig. 3. The level of TDONE differs considerably between the age groups and among the different samples. All the samples except the Scottish have higher previous treatment in the 12-year-olds than in the 5-year-olds (Fig. 3). The German sample has the highest level of previous treatment in 12-year-olds, the Scottish in 5-year-olds. The lowest level of previous treatment is seen in the 5- and 12-year-old children in the Italian samples.

Comparisons of means for TNEED, TNTIME and TDONE in the different samples resulted in the *P* values shown in Table 3, in which the mean value for each age group in each respective country is compared with the mean value for the respective age groups in all countries taken together.

In Figs. 4 and 5 the TNEED is given a negative sign and mirrored against TDONE for the 5-year-olds and for the 12-year-olds. In all of the samples, except the Scottish, the relationship between the two variables, TNEED and TDONE, is quite different in the 5-year-olds and the 12-year-olds.

To facilitate the understanding of the graphic illustration of treatment need in comparison with previous treatment that is, the relations of TNEED versus TDONE in each sample—these values are presented in percentages in Figs. 6 and 7. It should be noted that comparisons of these figures can be made only *within* each sample, as the figures illustrate the total treatment, namely $TNEED + TDONE = 100\%$, Total Treatment, for each sample.

When the treatment need is compared with the proportion of treatment previously provided in the various samples (Figs. 6 and 7), all samples except the Swedish and the Scottish have a higher treatment need than the proportion of treatment done in the 5-year-olds, whereas for the 12-year-olds only the Italian

Table 3. Comparisons of means for treatment need (TNEED), treatment need time (TNTIME), and treatment done (TDONE) in the eight countries. The mean value for the age group in all the countries is compared with the mean value for the age group in each country with the least significant difference test. The values in the table are *P* values. The following codes are used for the respective samples: I = Belgian, II = German, III = Greek, IV = Irish, V = Italian, VI = Scottish, VII = Spanish, and VIII = Swedish

Sample	TNEED		TDONE		TNTIME	
	5-year-olds	12-year-olds	5-year-olds	12-year-olds	5-year-olds	12-year-olds
I	0.060	0.017	0.074	0.016	0.143	0.619
II	0.099	0.003	0.019	0.001	0.119	0.000
III	0.975	0.000	0.496	0.000	0.124	0.379
IV	0.786	0.609	0.767	0.625	0.329	0.253
V	0.000	0.000	0.000	0.000	0.001	0.006
VI	0.856	0.186	0.820	0.075	0.000	0.975
VII	0.001	0.391	0.000	0.165	0.023	0.013
VIII	0.000	0.000	0.000	0.000	0.018	0.880

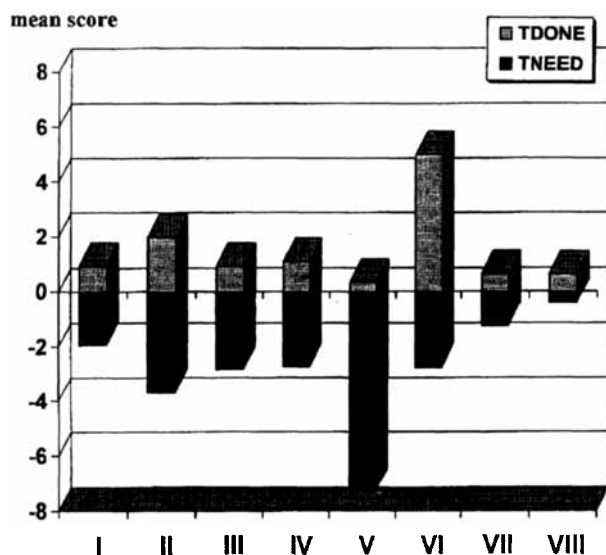


Fig. 4. Treatment Done (TDONE) and Treatment Need (TNEED) presented as mean score for the 5-year-old children in the eight samples. TNEED is given a negative sign. The following codes are used for the samples: I = Belgian, II = German, III = Greek, IV = Irish, V = Italian, VI = Scottish, VII = Spanish, and VIII = Swedish.

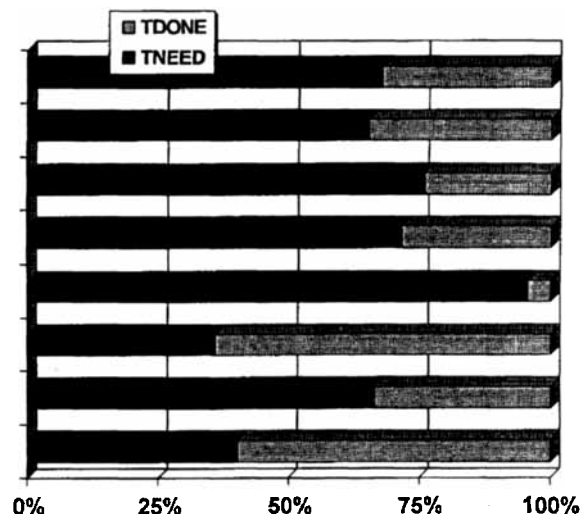


Fig. 6. The relation between Treatment Need (TNEED) and Treatment Done (TDONE) for the 5-year-old children in the eight separate samples. The figure monitors treatment remaining to be done in each sample compared with the amount of treatment already provided. The following codes are used for the samples: I = Belgian, II = German, III = Greek, IV = Irish, V = Italian, VI = Scottish, VII = Spanish, and VIII = Swedish.

sample has a higher treatment need in the 12-year-olds than the treatment already done.

To reflect the proportion of children unaffected by caries, the $dmft/DMFT = 0$ is a relevant measure. For the 5-year-old children with $dmft = 0$, these values were

74.0% in the Swedish sample, 71.5% in the Spanish, 56.0% in the Belgian, 54.5% in the Greek, 48.0% in the Italian, 46.0% in the Irish, and 37.5% in the German and Scottish samples. The corresponding values for 12-year-olds were 43.5% in the Spanish, 39.0% in the Italian, 38.5% in the Scottish and the Irish, 38.0% in the Greek, 37.5% in the Belgian, 35.0% in the Swedish, and 27.5% in the German samples.

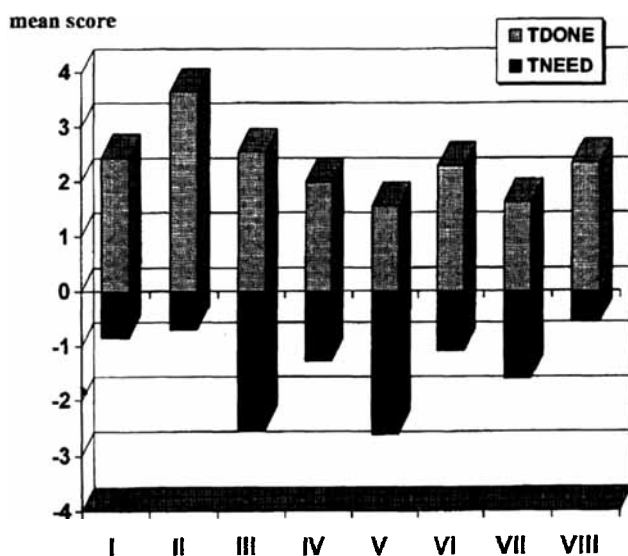


Fig. 5. Treatment Done (TDONE) and Treatment Need (TNEED) presented as mean score for the 12-year-old children in the eight samples. TNEED is given a negative sign. The following codes are used for the samples: I = Belgian, II = German, III = Greek, IV = Irish, V = Italian, VI = Scottish, VII = Spanish, and VIII = Swedish.

Discussion

With regard to treatment need in both 5- and 12-year-old children, there were major differences among the samples of participating countries. However, the reliability of these figures should be analyzed. After participating in a thorough calibration project shortly before the field work (1), the examiners were well calibrated both in recording of actual dental status and in assessing actual treatment need. With regard to the representativity of the samples, all the children are from urban areas, are of the same age, and have been selected in the same manner (2). When planning this collaborative study, there was general agreement among the participating countries that a national examiner should perform the examinations in his own country, not only for practical and economic reasons but also because a national examiner with good local knowledge could select children in accordance with the agreed selection criteria: children from areas that were both socioeconomically and ethnically representative of

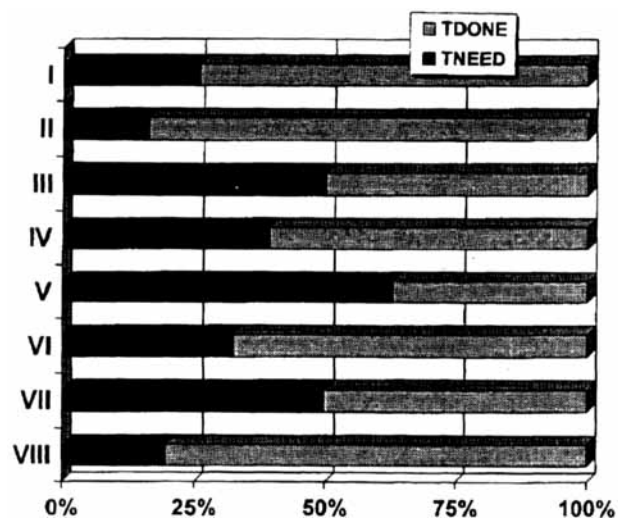


Fig. 7. The relation between Treatment Need (TNEED) and Treatment Done (TDONE) for the 12-year-old children in the eight separate samples. The figure monitors treatment remaining to be done in each sample compared with the amount of treatment already provided. The following codes are used for the samples: I = Belgian, II = German, III = Greek, IV = Irish, V = Italian, VI = Scottish, VII = Spanish, and VIII = Swedish.

the urban region in question. Because the children in all the participating countries live in greater urban areas, typical for most of the children in these countries, it is reasonable to assume that the results can be extrapolated to larger groups than the samples examined in each individual country. A conventional expression of dental health is the percentage of caries-free individuals measured as $dmft/DMFT = 0$ in the present sample. The figures presented in this study are in reasonable agreement with figures presented in national studies from Germany (5) and Ireland (6) and a recent study of 5-year-olds in Athens (7).

To create a measure that can be used to compare different volumes of treatment necessary in different populations, both in the primary and permanent dentitions, a method to calculate these treatment needs has been developed. The basis for development of this measure was the estimated treatment needed to repair damage caused by caries, for each tooth in each individual. In the present study the estimation was done by each national examiner in the participating countries at the time of the clinical examination of each child. It should also be pointed out that the variable TNEED was evaluated during the calibration procedures undertaken in each country, and good inter- and intra-examiner reliability had been achieved. The treatment need in each individual, TNEED, is calculated as the sum of the different treatment needs in the dentition. Calculation of treatment need is an attempt to express not only the number of surfaces diagnosed as carious but also the severity of the carious damage and

represents a weighted evaluation of the treatment efforts necessary to repair the damage due to caries.

Whether the weights applied to treatment need are appropriate may be questioned. The weights 1, 2, 3, 4, and 5 in the TNEED equation are chosen to represent the severity of one, two, or multi-surface fillings. The application of weights 4 and 5 to represent the severity of endodontic treatment and extraction, respectively, may also be questioned but was judged to be logical.

The validity of the TN scale was checked by calculating the TNTIME. The TNEED and the TNTIME showed nearly the same result. In accordance with this result, the TNEED calculations were judged to be adequate for estimation of the severity of carious damage. The TN scale can readily be applied to different population subgroups for estimation of actual treatment need due to caries.

There is a big difference in the need for extractions and endodontic treatment for 5-year-olds between, for example, the Italian and the Swedish samples. A previous paper (2) showed low numbers of restorations in the Italian sample. According to the results of this investigation the need for dental care in pre-school children seems to be most pronounced in the Italian sample. The large need for extractions in 5-year-old Italian children might indicate an even greater TNTIME, because multiple extractions in a child require not only time and clinical skills. Careful patient management may also be time-consuming but is essential, to ensure that the total treatment need can be provided. In the German sample the need for dental care in pre-school children is also pronounced compared with treatment need in the 12-year-olds. This is in agreement with another study from Germany (5).

TNEED reflects the present dental health. However, to reflect the total disease in an individual, an evaluation of treatment previously provided is also relevant. In this paper this is demonstrated in TDONE, calculated on an individual level, and in TNEED.

The influence of economic policies, treatment philosophies, and cultural attitudes on the differences between TNEED and TDONE will be analyzed in a separate paper on the organization of dental care systems in the participating countries. A later paper will also include a discussion of findings from the interviews, conducted as part of the overall project, to evaluate the possible role of psychosociologic factors in children's dental health, such as an association between dental fear in parents and unmet treatment need in their offspring.

Conclusion

A simple method to estimate treatment need was developed. The method is easily applicable to different population subgroups and shows a clear relationship with the time required to carry out the proposed treatment.

In the populations studied in the eight participating

EU countries, great differences in treatment need, treatment time, and previous treatment have emerged.

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